

**CARDIAC STRESS TESTS OR HEART SCANS:
ASSESSING THEIR EFFECTIVENESS**

Executive Development

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CERTIFICATION STATEMENT

I hereby certify that this paper constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions, or writings of another.

Signed:_____

ABSTRACT

The problem was that the Addison Fire Department's annual cardiac stress test, utilized as part of the employee Health and Wellness Program, was ineffective in determining an employee's heart health. The research purpose was to assess the effectiveness of cardiac heart scans in detecting and preventing potential heart conditions of our personnel. Through evaluative research, medical and fire department standards of measuring heart health were evaluated, along with the methods used by similar departments. Research also evaluated the effectiveness of the stress test verses the heart scan, which was carried out through surveys and literature reviews. The research showed Heart Scans are effective in detecting CAD. Changes were recommended to refine the annual stress tests and continue to include the Heart Scans.

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INTRODUCTION

According to the American Heart Association, sudden cardiac death is a major health problem, causing about 340,000 deaths each year among U.S. adults. Three-quarters of firefighters who died of heart attacks-the top cause of on-duty deaths-went to work with known or detectable heart conditions, according to a new analysis of firefighter fatalities from 1995 to 2004 by the National Fire Protection Association (Fahy, 2005, ¶ 1). Much emphasis has been placed on fireground safety and accountability. However, this is not the number one cause of fatalities for U.S. firefighters. More emphasis must be placed on detecting, and preventing the number one cause of firefighter deaths, which is sudden cardiac death.

The Addison Fire Department (AFD) has been at the forefront when it comes to firefighter wellness and fitness. We have had a mandatory physical fitness policy along with annual physicals and stress electrocardiograms (ECGs) for all personnel since 1985. This program has been a tremendous benefit over the years. However, as many of our employee near retirement, we have seen an increase in heart-related problems.

This research focuses on the fact that AFD's annual cardiac exercise stress tests, which have been utilized as part of the employee Health and Wellness Program, have not been sufficiently effective in determining, with accuracy, an employee's heart health. Exercise stress tests performed on a treadmill and evaluated by a cardiologist have been used to determine if significant blockage of coronary arteries has occurred in our personnel. This method, however, has detected very few, if any, significant coronary artery disease (CAD) prior to cardiac symptoms or a significant heart event.

The research questions are:

1. What are the standards for measuring heart health?
2. What standards are utilized by the fire service to measure heart health?
3. What methods are other agencies of similar size and demographics utilizing to determine the heart health of their employees?
4. How do the annual cardiac stress tests for the Addison Fire Department compare to other agencies of similar size or demographics in detecting heart conditions?
5. How effective have the annual cardiac stress tests been in predicting or preventing heart attacks within the Addison Fire Department?
6. What are the recommended cardiac tests for the Addison Fire Department?

BACKGROUND AND SIGNIFICANCE

The Town of Addison is located along the northern border of Dallas, Texas and is surrounded by several suburban areas. It is a very unique community consisting of only 4.3 square miles and a resident population of approximately 15,000 people. However, the daily daytime/evening population may easily exceed 100,000 people due to the many businesses, hotels, restaurants, retail, mid-rise office buildings, light industrial and commercial properties. The Town also supports one of the busiest general aviation airports in the country and has a very high volume of traffic on its roadways. The AFD is a rather young department, with its first paid members beginning in 1971. Today it employs 48 paid personnel in operations out of two stations, with equipment staffed by certified firefighter/paramedics who are also Basic Aircraft Rescue trained. AFD provides both fire and emergency medical services and also employs seven personnel in the administration and prevention division.

During the 1980s, the AFD recognized the importance that the role physical fitness and regular health screening played in keeping its members healthy. Several personnel were trained

as certified physical trainers who later helped develop a required physical fitness policy for all fire department employees. The Town also initiated health screenings for fire department employees which included blood analysis, body fat percentage testing, resting ECGs and exercise stress tests. This program has continued over the years with obvious benefits to the employee. Tak & Gutierrez found that used correctly, the ECG stress test can help confirm the diagnosis of CAD in symptomatic patients (2004, ECG Stress Testing section, ¶ 1). For example, as a result of the screenings over the years, several employees were found to have some type of heart condition and began treatment, which potentially kept their conditions from getting worse. While the screenings have been unquestionably beneficial, unfortunately, over the past twelve years there have also been eight cases where the exercise stress tests did not indicate the presence of significant CAD or heart abnormalities, yet the employees suffered significant heart events within weeks or months following those tests. In fact, one employee suffered a heart attack at work, was defibrillated and was revived. Others suffered heart attacks soon after the stress tests that showed no indication of blockage and either had coronary by-pass surgeries or received stents to open up clogged arteries. After some initial investigation it was determined that this was not unique to the AFD. Several other departments that were contacted indicated they were experiencing the same problem. Tak & Gutierrez state that the overall sensitivity and specificity of exercise stress testing for CAD are about 63% and 74% in some groups, particularly when used as a screening method (2004, ECG Stress Testing section, ¶ 2).

The AFD began investigating more reliable and cost effective alternatives to the exercise stress test several years ago. This was done in an attempt to identify CAD in its earlier stages through preemptive intervention and recognition with the intent of reducing the occurrence of significant detrimental heart events in our personnel. The method chosen was a diagnostic

method known as Electron-Beam Computed Tomography (EBCT), also known as a Heart Scan. Heart Scans are utilized as an alternative diagnostic test, are non-invasive and can detect and quantify calcium deposits in the coronary arteries (AdvaMed, 2000, ¶ 4).

The number of heart related deaths in the fire service is obviously a major problem as indicated by a recent study by the National Fire Protection Association (NFPA). “From 1995 through 2004, 440 firefighters, or almost half of the total number of firefighters who died on duty, fell victim to sudden cardiac death, and close to half of those with documented prior medical conditions had known heart problems” (Fahy, 2005, Summary Section, ¶ 1). The United States Fire Administration (USFA) along with the Department of Homeland Security (DHS) have recognized the importance of this problem by establishing Standards such as NFPA 1500, Standard on Fire Department Occupational Safety and Health Program and NFPA 1582, Standard on Comprehensive Occupational Medical Program for Fire Departments. This research will assess the effectiveness of cardiac heart scans in detecting and preventing potential heart conditions and is directly related to one of the USFA Operational Objectives to reduce the loss of life of firefighters from fire, as stated in the National Fire Academy’s Executive Development course.

This research will assess the effectiveness of the Heart Scan in detecting heart related problems. This investigation will be carried out by using the Evaluative Research Method. Through the use of standard feedback questionnaires, personal interviews and literary review, this research will determine whether or not to continue utilizing the Heart Scan and identify any possible modifications to the AFD’s Health and Wellness Program.

LITERATURE REVIEW

Firefighter health and wellness has been at the forefront over the past several years because of the high incidence of firefighter fatalities. Although the AFD has been very progressive when it comes to early initiation of mandatory physical fitness and a health and wellness program, it has still fallen short in the early detection and prevention of heart related problems. A recent study at Texas A&M University investigating the risk of a firefighter having a heart attack found that long periods of stress free activity interrupted by sudden, intense energy demands on an unfit firefighter could be deadly (Womack, 2001). The focus of the literary research was to first define what the standards were for measuring heart health in the medical community. Second, it was utilized to determine what standards were being utilized by the fire service to measure heart health.

The normal heart is a strong, muscular pump slightly larger than a clenched fist. It must pump blood continuously through the circulatory system. According to the American Heart Association, each day the average heart expands and contracts 100,000 times, pumping about 2,000 gallons of blood (2005, ¶ 1). A healthy heart consists of four chambers. The upper chambers consist of the right and left atrium, and the lower chambers consist of the right and left ventricles. Each chamber has one way valves that allow blood to flow in one direction throughout the heart, to the lungs for oxygenation, and then throughout the body. The heart muscle requires its own blood supply, which is supplied by the coronary artery. In order for the heart to function properly, this artery needs to be free of buildup or coronary artery calcification which is part of the development of atherosclerosis; it occurs exclusively in atherosclerotic arteries and is absent in the normal vessel wall (ACC/AHA, 2000, Executive Summary section, ¶

1). The most common risk factor for cardiac arrest and sudden cardiac death in the United States is from atherosclerotic CAD (NIOSH, 2000, Discussion Section ¶ 1).

Risk factors play an important role in determining who might be at a higher risk of disease. In this case, the major risk factors are those that research has shown lead to a significant risk of developing CAD. One of the most famous and longest running studies concerning cardiovascular disease is the Framingham Heart Study conducted by the National Heart, Lung, and Blood Institute (NHLBI), through Boston University. This study and the American Heart Association agree that there are common risk factors associated with CAD. Those risk factors include high blood pressure, high blood cholesterol, smoking, obesity, diabetes and physical inactivity, as well as the role age, gender, heredity, stress and alcohol play in cardiovascular disease (NHLBI/AHA, 2005, Generation III section, ¶ 2). Certain values have been assigned to blood pressure and cholesterol readings to reflect a range from low to high to determine the relative risk. These assigned values are calculated along with all the other risk factors to determine the likelihood of cardiovascular disease and the probability of suffering some type of heart related event over time. Knowing risk factors helps identify individuals who are at increased risk of CAD; however, they can only indicate who might be more prone to heart disease. Clinical testing is needed to confirm the presence of CAD.

Detecting the presence of CAD is most often accomplished through the use of the exercise stress test. The term exercise stress test refers to measuring a response by the body by putting an exercise stress load on it (IAFF, 2005, Exercise Stress Testing section, ¶ 1). Stress tests are performed by a doctor or a trained technician to determine the amount of stress (or exertion) that a heart can manage before developing either an abnormal heart rhythm or evidence of a lack of blood flow to the heart muscle (IAFF, 2005, Exercise Stress Testing

section, ¶ 7). The stress test is usually performed on a treadmill or a stationary bike while the patient is being monitored by an electrocardiogram (ECG) and having his blood pressure monitored throughout the testing.

Doctors use the stress test for several reasons. It is used to determine if there is adequate blood flow to the coronary arteries during exertion and to check the effectiveness of prescribed medication, or to detect improved blood flow to the heart following surgery. Furthermore, it can help identify any abnormal heart rhythms or help with the development of a safe exercise program.

Cost is obviously a major consideration for any fire department's health and wellness program, especially when considering today's shrinking budgets. It is essential that whatever testing is done be cost effective in terms of a cost-benefit ratio. There are many different types of stress tests utilized today for detecting CAD. They may range in price from \$150 for the treadmill or stationary bicycle test up to several thousand dollars for radionuclide tests. One of the most widely used and least expensive investigative techniques in cardiology is the ECG stress test (2004, ECG Stress Testing section, ¶ 1).

A relatively newer method for the early detection of CAD is the Electron Beam Tomography (EBT), which is also referred to as a Heart Scan. The Heart Scan is a non-invasive test, very similar to taking an x-ray, used to detect calcification in the coronary arteries. The Heart Scan does not determine a patient's propensity to have a heart attack. Instead, it detects calcified plaque in the arteries of the heart, which is an indication of heart disease (Scandirect, 2005, Heart Scan section, ¶ 6). However, according to the American Heart Association (AHA) a coronary calcium score derived from the EBT is known to predict the occurrence of cardiac

events, such as fatal and non-fatal heart attacks, or the need for coronary bypass surgery or angioplasty over the next year or two (AdvaMed, 2005, ¶ 2).

According to Payne, the Heart Scan is usually conducted by a qualified physician or radiologist with test results measured by a calcium score. A score of 0 indicates there is no evidence of plaque, meaning there is a less than 5% chance of CAD and a very low risk of having a heart attack. A score of 1-10 indicates a small amount of plaque, which translates to a less than 10% chance of CAD and a low risk for a heart attack. Scores between 11-100 indicate CAD which is mild in nature with a moderate risk for a heart attack. A score of 101-400 means plaque is present in moderate amounts and may possibly indicate blocked arteries. Scores of over 400 indicate a 90% chance there is blockage in at least one artery and further testing is recommended (2003, Cardiac Calcium Scoring section, ¶ 19).

The cost of the Heart Scan is more than double that of the exercise stress test, which may make the test cost prohibitive to some departments. The current charge for the Heart Scan is between \$350 and \$400, which includes interpretation of the results by a physician. Furthermore, high calcium scores from the Heart Scan would need to be followed up with further testing to determine the presence of CAD and the need for further treatment.

Many fire departments currently have some type of health and wellness plan which usually includes a comprehensive evaluation by a physician as part of a new-hire process and/or an annual evaluation. This evaluation is used to measure the health of the employee. This evaluation typically involves questions concerning family history of medical problems, lifestyle and medications. It may also include blood analysis, baseline heart rate, resting ECG, pulmonary function test, chest x-rays, eye exam and hearing tests. Risk factors for CAD should also be obtained which include age, gender, use of tobacco, high blood cholesterol and blood pressure,

obesity, inactivity, diabetes, stress and alcohol. This evaluation should be conducted prior to any exercise stress test to determine pre-existing conditions or indicate further testing.

The annual evaluation often includes some type of exercise stress test. One of the most common types of exercise stress tests used by the fire service today is the stationary bicycle or treadmill test with the ECG. This test can help identify heart rate and rhythm abnormalities as well as significant CAD. The International Association of Fire Fighters (IAFF)/International Association of Fire Chiefs (IAFC) Service Joint Labor/Management Wellness-Fitness Initiative recommends a sub-maximal stress test without ECG because of the safety of the test (IAFF, 2005, Exercise Stress Testing section, ¶ 2). This type of testing only allows for sub-maximal rates that are typically determined to be 85% of the firefighter's pre-determined maximum heart rate. They are usually done on a treadmill or stairmill. Should the test show signs of abnormalities, the testing process is halted and the employee is referred for further diagnostic testing (IAFF, 2005, Exercise Stress Testing section, ¶ 2).

Many of the standards for measuring heart health have been developed with the help of the Framingham Heart Study and the American Heart Association. These organizations have identified key risk factors that play a role in determining the likelihood of someone developing CAD or suffering sudden cardiac death. There are many different types of diagnostic tests with varying costs and associated risk information available to help in determining the presence of CAD. The most common test is the exercise stress test with the ECG, which is then followed by further testing if abnormalities are found. However, more advanced tests such as Stress Echocardiograms, Thallium Stress Tests, and Positron Emission Tomography (PET) Scans are typically not initially utilized to screen for the presence of CAD due to the higher cost of the procedures and potential risks to the patient. The IAFF/IAFC Fire Service Joint

Labor/Management Wellness-Fitness Initiative recently made recommendations related to fire service standards for health and wellness. Many fire departments are currently utilizing some type of exercise stress test along with the electrocardiogram to identify the possibility of CAD.

PROCEDURES

The first part of this research began by examining literature from various resources available through the internet and the student library of Texas A&M University in College Station, Texas. These resources were utilized to answer questions #1 and #2:

1. What are the standards for measuring heart health?
2. What standards are utilized by the fire service to measure heart health?

The initial search focused on the topic of heart health and how this is measured in the medical community. Through researching information provided by the American Heart Association, medical journals and studies related to circulation, heart disease, cardiology and stress testing, it was discovered that most of the information related back to the Framingham Heart Study conducted by the Heart, Lung and Blood Institute. Much of the information gained through the Framingham Study focuses on the risk factors associated with CAD.

The second part of the research evaluated the various methods or tools that were utilized for measuring heart health. This research mainly focused on the exercise stress test with the use of electrocardiograms because this method is the most widely used test in initially detecting CAD, and it has been utilized by the AFD for over 20 years. It has also been the most widely-used tool by fire departments and has been recommended by recent fire department health and wellness initiatives. Electron Beam Tomography, or Heart Scan, was also a focus of examination in this research due to the relative cost-effectiveness of this newer technology and because the AFD utilized this procedure for the first time during its most recent annual physical

examinations. No other types of diagnostic testing were researched in depth because they are typically utilized after an exercise stress test to either confirm the findings of the stress test or to determine the extent of CAD or plaque buildup in the coronary arteries. They are also more expensive and may present a greater risk to the patient. It was also important to investigate the recent recommendations by the IAFF and IAFC along with NFPA Standard 1582 concerning health and wellness.

The second part of the process was characterized by the use of surveys, which were sent to other departments, mostly within the State of Texas, to answer question #3 and #4:

3. What methods are other agencies of similar size and demographics utilizing to determine the heart health of their employees?
4. How do the annual cardiac stress tests for the Addison Fire Department compare to other agencies of similar size or demographics in detecting heart conditions?

The first survey was distributed through an e-mail distribution list of Texas Fire Chiefs and through personal contacts of the author. This method was chosen in order to randomly sample as many fire departments as possible with a similar number of personnel and demographics. The survey was developed to assess how many similar fire departments currently utilize a health and wellness screening process, how long it has been utilized, whether or not an exercise stress ECG was part of the process and if the departments felt it was an effective tool in determining heart health. Furthermore, the survey determined if a Heart Scan was being used and if they felt it was an effective tool in determining heart health. The surveys were e-mailed on October 31, 2005 with a requested return date of November 9, 2005 either by e-mail or fax. The survey included the author's name, title and organization, it explained the purpose, and it included instructions on how to complete and return the survey. The respondents were also

advised that their responses would be kept anonymous and the results would be shared upon request. There were 76 surveys returned, 26 eliminated and 50 utilized for data. (see Appendix A). The focus was narrowed down to agencies of similar size and demographics by eliminating fire departments that were not fully paid and/or contained more than 300 personnel.

The second survey was distributed to the employees of the AFD who participated in the Heart Scan offered by the department. In addition, personal interviews were conducted in order to answer question #5:

5. How effective have the annual cardiac stress tests been in predicting or preventing heart attacks within the AFD?

Only the participants in the Heart Scan were chosen to complete this survey in order to evaluate their opinion of the effectiveness of the Heart Scan and to determine if it caused them seek further medical testing or changed their health habits in any way. The survey was e-mailed by the author on October 31, 2005 with a requested return date of November 4, 2005 either by e-mail, fax or in person. The survey included the author's name, title, and organization, it explained the purpose, and it contained instructions on how to complete and return the survey. The respondents were also advised that their responses would be kept anonymous and the results would be shared upon request. Twenty-four surveys were sent out and 23 were returned (see Appendix B).

To answer question #5, personal interviews were conducted with present and former AFD personnel who have experienced some sort of heart related event either while employed with the AFD or following retirement. The interviews were conducted over the week of November 13, 2005 either over the phone or in person at the fire station. The interview questions were a result of what was found in the literature review concerning exercise stress tests and the

risk factors associated with CAD. Twelve personnel were identified as having some type of heart event either while employed with the AFD or following retirement. Ten personnel were interviewed (see Appendix C).

Question #6 will be answered in the Recommendations section.

The Heart Scans were initiated this year in addition to the exercise stress test for all employees 40 years of age and older with the objective of earlier detection of CAD, especially in those without symptoms of the disease. A limitation on this method was the Heart Scans are a relatively new tool utilized by fire departments as an early detection method for CAD. Only one research paper was found concerning calcium scoring in the NFA's library. Therefore, there was little information available from the fire service as to the effectiveness of Heart Scans. Another limitation was females were not considered in this research because the data on females is different than males and the AFD currently has no female employees.

RESULTS

Through evaluative research, which included reviews of many written resources as well as surveys from other fire departments and current and former employees, the author was able to answer the six research questions.

Question #1. What are the standards for measuring heart health?

A healthy heart requires a functioning pump, free of build up in the arteries, called plaque, and free of arrhythmias, which is an alteration in rhythm of the heartbeat (Merriam-Webster, 2005). To determine the standards for measuring heart health, the author investigated the leading risk factors that lead to atherosclerotic CAD, or plaque in the arteries, since risk factors of heart disease play a major role in who might suffer a cardiac event and helps identify those who would benefit from testing for heart disease.

The Framingham Heart Study began in 1948 with an objective of identifying the common factors that contribute to cardiovascular disease (NHLBI, 2005, ¶ 2). The American Heart Association and the National Heart, Lung and Blood Institute agree that several risk factors increase the risk of CAD and heart attack. Some of the risk factors that are unchangeable include increasing age, gender and heredity. Those that can be modified or controlled are tobacco use, high cholesterol, high blood pressure, physical inactivity, obesity, diabetes, stress and alcohol (AHA, 2005, ¶ 3). Possessing any one or more of these risk factors increases the likelihood of developing heart disease.

Identifying risk factors is the initial step in determining a healthy heart. The second step is detecting the presence of CAD. The research indicates that stress tests have been used for more than 50 years in identifying people with heart disease and directing treatment. The most commonly performed stress test appears to be the exercise stress test while an ECG is being performed. The stress test is usually performed on a treadmill, stationary bicycle or some type of stairmill while the patient is being monitored with an ECG for arrhythmias, heart rate and blood pressure to determine adequate blood flow to the heart during exertion. An abnormal test result would suggest further diagnostic tests to determine the exact locations of blockage or restriction and the extent of the problem.

Prior to any stress test, the individual must be evaluated by a physician to determine if it is safe to start exercise. This evaluation should include a basic physical exam including blood analysis, resting ECG, demographic information, medical history including risk factors, chest x-rays and a pulmonary function test.

As with any other test, certain drawbacks to the exercise stress test do exist. For example, the individual must be physically able to do the exercise. Additionally, some

individuals may not exhibit an abnormal test and still have significant heart disease and vice versa. In addition, some may indicate a false positive for heart disease. Additional testing would still be recommended to clarify the results at an additional cost.

An alternative diagnostic method used in measuring heart health is a non-invasive computer scan of the heart that can detect and quantify calcium deposits in the coronary arteries is the Electron Beam Computed Tomography Scan, or Heart Scan (AdvaMed, 2005, ¶ 2). This scan is used to diagnose CAD in an early stage and to determine its severity. The Heart Scan takes about ten minutes to complete and is similar to an x-ray in that it is able to capture several images of the heart between a single heart beat, producing clear images of the heart and arteries. This scan is able to detect small amounts of calcium (or plaque) within the heart and coronary arteries, which is then assigned a calcium score. This calcium score is translated on a scale from 0 (low risk), to 11-100 (moderate risk) and over 400 (high risk). The higher the score, the more plaque there is in the coronary arteries and the higher the risk of having a heart attack.

The Heart Scan is recommended for men 40 years of age and older and women 45 years of age and older who have a strong family history of heart disease or have one or more of the risk factors for CAD as defined by AHA. This test is not recommended for healthy individuals without risk factors. The Heart Scan does have some limitations. For example, it is not able to detect the early stages of calcium deposits, which is called soft plaque. In addition, a false-positive test is possible and more likely in those with a low risk for CAD. Finally, the procedure is currently not covered by most insurance plans.

Question #2 What standards are utilized by the fire service to measure heart health?

The standards for measuring heart health in the fire service vary with each department. The AFD has had a health and wellness plan for many years, and part of that plan involves an

annual physical for all employees. The part of the annual physical related to heart health includes a medical history, blood pressure screening, and blood analysis to test for cholesterol levels and diabetes and a resting ECG. In addition, all employees 40 years of age and older had Heart Scans and an exercise stress test with ECG performed, which was interpreted by a cardiologist. Any problems found as a result of the physicals were followed up with the member's personal physician. The physicals were followed up by a physical ability test for all members, which was developed by The Cooper Institute in Dallas, Texas. The test was job specific and very similar to the candidate physical agility test (CPAT) developed by the Fire Service Joint Labor Management Wellness-Fitness Task Force (FEMA, 2002, p. 43).

General heart health standards for the fire service are outlined in the recommendations from the NFPA 1500, Standard on Fire Department Occupational Safety and Health Program and NFPA 1582, Standard on Medical Requirements for Fire Fighter and Information for Fire Department Physicians. NFPA 1500 requires that candidates be medically evaluated and certified by a fire department physician. NFPA 1582 states that the fire department is only obligated to provide basic medical evaluations at no cost to the employee. The recommendations from the NFPA concerning the evaluation of the heart consist of a baseline physical including the risk factors for CAD and a resting ECG. Furthermore, stress ECGs are only recommended as clinically indicated by the medical history or symptoms.

Recently, the International Association of Fire Fighters, in cooperation with the International Association of Fire Chiefs joined together to develop the Fire Service Joint Labor/Management Wellness-Fitness Initiative. They have recommended cardiopulmonary testing for all emergency responders as part of pre-employment testing and then annually

thereafter (IAFF, 2005, Exercise Stress Testing section, ¶ 4). Furthermore, they recommend a procedure called a sub-maximal exercise stress test without the ECG.

Question #3 What methods are other agencies of similar size and demographics utilizing to determine the heart health of their employees?

Question 4: How do the annual cardiac stress test for the Addison Fire Department compare to other agencies of similar size or demographics in detecting heart conditions?

Questions #3 and #4 were answered by a survey distributed to approximately 400 departments through a statewide fire chief's organization via the internet (see Appendix A). A total of 77 surveys were returned. In order to evaluate agencies of similar size and demographics, all combination and volunteer departments were eliminated as well as departments with more than 300 personnel. A total of 49 fire department surveys were evaluated with an average of 82 personnel per department. The questions and results of this survey are as follows:

Question: Does your fire department currently utilize a health and wellness program or annual health screening? A total of 40, or 82%, did, and 9, or 18%, did not. Those without a program were considered to be finished with the survey and were asked to return it.

Question: For those who had a program or annual health screening. How long has the program been in place? Less than 1 year = 5, or 12 %; 1-3 years = 10, or 25%; 3-5 years = 2, or 5%; 5 or more years = 23, or 57%.

Question: Is a stress electrocardiogram included as part of your department's health and wellness program or annual health screening? 26, or 65% said Yes; 14, or 35% said No

Question: If yes to question above, in your opinion, has the stress ECG been an effective tool in detecting cardiac problems in your personnel?

18, or 75% said Yes; 6, or 25% said No.

Question: Is a Heart Scan included as part of your department's health and wellness program or annual screening. 3, or 6% said Yes; 46, or 94% said No.

Question: Has the Heart Scan been an effective tool in detecting cardiac problems in your personnel. All three, or 100% said Yes.

A comments section was provided for any additional feedback.

The survey indicates that of the 49 career departments responding, 82% currently have some type of health and wellness program. Of those, 57% have had such program for 5 years or more. This information was important in establishing a baseline for health screening in order to evaluate the effectiveness of the stress testing being performed. Of the 40 departments with a health and wellness program, 26, or 65%, include the stress ECG in the annual screening with 25% stating they did not feel it was an effective tool in detecting heart problems. Of the 49 departments surveyed, only 3 departments, or 6%, are currently utilize the Heart Scan, and all 3 feel they are an effective tool in detecting heart problems. Comments provided by the respondents can be categorized by three prevailing opinions. First, two respondents stated an exercise stress test with ECG revealed some type of heart problem requiring treatment through medication or surgery on four personnel and that one had a false positive test. Secondly, one large department indicated that its cardiologist did not feel the heart scan technology was adequate to provide reliable results. Lastly, six different respondents stated that they are looking into using Heart Scans or will utilize them next year because of their dissatisfaction with the reliability of the exercise stress ECGs. One of these six stated that an exercise stress ECG was done indicating no problems on two personnel, and within weeks they suffered heart attacks.

Part of Question #4 is answered here: In March 2005, the AFD utilized the Heart Scan for the first time as part of the annual physical exam. Upon completion of the basic physical exam, all personnel 40 years of age and older were scheduled to receive the scans to determine a baseline through a calcium score for CAD. Twenty-eight personnel completed the test over several weeks with the following results: Eleven members scored a zero in the calcium scoring which indicates no evidence of plaque and a less than 5% chance of CAD. Nine personnel scored 0-10, which indicates plaque is present but the risk of heart attack is low. Two personnel scored between 11-100, which indicates mild hardening of the arteries. Two personnel also scored between 101-400, which means the risk is moderate and the possibility of a blocked artery exists. Four personnel scored over 400 which indicates a more than 90% chance that plaque is blocking an artery (Payne, 2003, ¶ 19). Six personnel sought follow-up medical advice and testing, four of these began treatment for cholesterol and high blood pressure, one had surgery with a stent put in a coronary artery and one was determined to have received a false-positive from the scan.

The overall consensus among AFD personnel who participated in the first Heart Scans was that the test was very effective, and all of the respondents indicated a desire to continue receiving Heart Scans as part of the AFD Health and Wellness Program in the future (see Appendix B).

Question #5: How effective have the annual cardiac stress tests been in predicting or preventing heart attacks within the Addison Fire Department?

Question #5 was answered through personal interviews with current and former employees of the AFD. These interviews occurred over the course of several weeks either in person or over the phone. Nine personnel were identified as having some type of significant

heart event either while they were employed or following their retirement with the AFD. All nine had taken part in the annual physical exams offered by the fire department during their employment, which included exercise stress ECGs. I was unable to make contact with one of the former employees. The average age of the eight personnel interviewed when the first heart event occurred was 48.8 years old. The interview questions were as follows:

Question 1. At what age was your first heart-related event? Individual ages will not be revealed for privacy reasons.

Question 2. Have you ever been diagnosed with high cholesterol? 4 said Yes; 4 said No.

Question 3. Have you ever been diagnosed with high blood pressure? 5 said Yes; 3 said No.

Question 4. Have you ever been diagnosed with diabetes? 4 said Yes; 4 said No.

Question 5. Do you currently smoke? All said No.

Question 6. Do you have a family history of heart disease? 7 said Yes; 1 said No.

Question 7. Are you characterized as “obese?” 3 said Yes; 5 said No.

Question 8. Are you physically inactive? 8 said No.

Question 9. While employed with the AFD, did you receive an exercise stress test?

All 8 said Yes. How many? The average was 5 tests each.

Question 10. Did the test reveal any CAD or other heart abnormalities? 7 said No; 1 had a false positive.

Question 11. Have you suffered a significant heart-related event after a negative exercise stress test? 7 said yes; 1 said No (the false positive).

Question 12. How soon after the test? This varied from 5 months to 1 year for the current employees and from 5 months up to 5 years for the retired employees.

Question 13. What type of problem and what was the treatment?

Of the four current employees, one employee received a double by-pass operation 5 months after a stress test; one had a triple by-pass; one had a stent put in place one year after a stress test; and one had a cardiac arrest in the fire station, was revived, and received a quadruple heart by-pass 10 days later. Of the retired personnel, one had a triple by-pass 5 months after retirement and after the stress test; one had a double by-pass within 4 years; and one had a quadruple by-pass 5 years later. One retiree's stress test revealed a false positive during his employment, and he has had no heart-related complications to date.

All the questions for this interview were chosen because they characterize the risk factors for developing CAD as described by the Framingham Study and the AHA. It was important to distinguish the fact that all of these personnel had several risk factors that indicated the benefit of further testing.

Question 6: What are the recommended cardiac tests for the Addison Fire Department? This question will be addressed in the Recommendations section of this paper.

DISCUSSION

Through literature review of the latest information concerning the measurement of heart health and the standards utilized in the fire service, it is clear that much of what has been learned about heart health stems from the Framingham Heart Study. A 1999 French study found that patients with a previous history of a heart attack, or those with more than one risk factor for heart disease, all had a higher risk of suffering a major cardiac event over the next six years (Schwanke, 1999, ¶ 1). These studies are consistent with the AHA concerning risk factors that indicate a person's likelihood of developing CAD, which is a precursor to a heart attack. No evidence was revealed in any of the literature to dispute these findings. It was clear from the literature that risk factors for CAD should be utilized as a tool for any fire department's health and wellness plan. The

standard in the medical community for actually detecting heart problems is the exercise stress test with ECG.

The standards for measuring heart health in the fire service can be found in the recommendations by NFPA Standard 1582, Standard on Comprehensive Occupational Medical Program for Fire Departments and through the IAFF/IAFC Fire Service Joint Labor/Management Wellness-Fitness Initiative. Both of these organizations recommend annual physical exams along with exercise stress tests. However, the IAFF/IAFC recommend a sub-maximal exercise stress testing without ECG initially, and NFPA 1582 recommends a “stress ECG with or without echocardiography or radionuclide scanning as indicated by history or symptoms” (NFPA, 2003, 7.9.2). The survey of other departments indicated a majority did offer stress tests; however, it was not clear if they included ECGs. Most of these department’s (75%) indicated the stress ECGs were effective in detecting heart problems; however, only two stated the stress ECGs had actually detected problems from the test. This is indicative of the finding by Tak, who states the overall specificity of this test in detecting CAD, particularly as a screening method, is between 63% - 74%. Of the 25% of respondents who stated the ECGs were not effective in detecting heart problems, all were either using the Heart Scan or looking into it.

Most departments surveyed had some type of health and wellness plan in place and a majority had such a plan in place for more than five years. The AFD has had a mandatory physical fitness program since 1985 along with an annual physical exam for all employees. The exercise stress ECGs were also offered to those employees 40 years of age or older, but there were several years the exercise stress ECGs were not offered due to budget constraints or other reasons. Since 1992 these tests have not detected any cardiac related problems in AFD personnel, although three current and two retired members have either had stents or by-pass

surgeries in the past four years. It is for this reason the AFD began looking at alternatives to the exercise stress test with ECG.

Heart Scans appeared to be a promising alternative, although it was a relatively new technology. Most of the studies seemed to agree with an American College of Cardiology/American Heart Association study that did not recommend Heart Scans for diagnosing CAD because of the high percentage of false-positive results and because there was not enough data to support a direct correlation between high calcium scores and CAD. However, many of the recent studies suggest otherwise. A 2002 Tulane University study found that 36% of people with very high calcium scores either had heart attacks or died from sudden heart deaths (Smith, 2002, ¶ 6). Two of the most recent studies also support a strong relationship between calcium scores and premature CAD and that Heart Scans provide high accuracy for non-invasive detection of CAD (Hoffman, et al., 2005, Conclusions section, ¶ 1). In fact, “coronary calcium was associated with an 11.8-fold increased risk for incident coronary heart disease (CHD)” (Taylor, et al., 2005, p. 807). The AFD’s initial experience with the Heart Scan has been very positive, recognizing potential heart problems when the exercise stress ECGs have not. Five personnel were identified as having potential heart problems following the first scan and began preventative treatment, which suggests very promising results.

RECOMMENDATIONS

The results of this research have confirmed the decision of the AFD to utilize the Heart Scan as part of the overall health and wellness program. However, the data collected and the analysis of that data suggest changes that may be more cost-effective, have more potential of reducing the risk of CAD, and be a better tool for prevention as opposed to detection.

The following are recommended changes to the health and wellness program to ensure the annual cardiac tests in the AFD are better able to recognize the heart health of its employees.

- Stress the importance of recognizing the risk factors of CAD to the employees so they can make informed decisions concerning their personal health.
- Utilize risk factors of CAD in determining the employees who are at greater risk of having heart problems and schedule testing accordingly.
- The use of Heart Scans should continue, and all those with high calcium scores should be encouraged to seek further testing to confirm the presence of CAD and initiate treatment.
- Exercise stress ECG should follow Heart Scans if the results of the scan are in the moderate risk range for CAD.
- Regular exercise has proven to reduce risk; therefore, daily fitness and exercise must be a mandatory part of every health and wellness program.
- Additional research is needed to determine how accurate calcium scores are at predicting CAD and heart attacks.
- The AFD should continue to conduct follow-up evaluations of its personnel to determine the effectiveness of the Heart Scans and stress tests.

The AFD personnel will benefit from these recommendations through an increased awareness of their personal heart health. The organization will benefit by enacting guidelines for testing and setting the goal of detecting CAD early on, resulting in the establishment of preventative measures as opposed to the continued reaction to major heart problems.

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APPENDIX A

*This survey will be utilized for a National Fire Academy Executive Fire Officer Program Applied Research Paper. All responses will be kept anonymous, and I will be happy to share the results of the survey upon request. I would appreciate your feedback by responding to the following questions. **Please submit your completed survey no later than Wednesday, November 9, 2005.** You may either e-mail it to ckellen@ci.addison.tx.us or fax it to (972) 450-7208.*

1. How many personnel are in your Fire Department?
2. Is your Fire Department:

☐ Fully Paid

☐ Volunteer

☐ Combination
3. Does your fire department currently utilize a health and wellness program or annual health screening?

☐ Yes ☐ No
4. If the answer is NO to question number 3, please return the survey. Thank you for your participation.

If YES, how long has this program been in place?

☐ Less than 1 year

☐ 1 - 3 years

☐ More than 3 years - 5 years

☐ More than 5 years
5. Is a Stress Electrocardiogram included as part of your department's health and wellness program or annual health screening?

☐ Yes ☐ No

IF YES, please proceed to question 6. IF NO, Please proceed to question 7.

6. If YES, in your opinion, has the Stress Electrocardiogram been an effective tool in detecting cardiac problems in your personnel?

☐
Yes

☐
No

7. Is a Heart Scan (Electron Beam CT Scan) included as part of your department's health and wellness program or annual health screening?

☐
Yes

☐
No

If YES, please proceed to question 8. If NO, proceed to Comments.

8. In your opinion, has the Heart Scan been an effective tool in detecting cardiac problems in your personnel?

☐
Yes

☐
No

If you have any comments or wish to elaborate on any of these questions please do so below.

Deputy Chief – EMS/Training
Addison Fire Department
(972) 450-7206
(972) 450-7208 Fax

APPENDIX B

*This survey will be utilized for a National Fire Academy Executive Fire Officer Program Applied Research Paper. All responses will be kept anonymous, and I will be happy to share the results of the survey upon request. I would appreciate your feedback by responding to the following questions. **Please submit your completed survey no later than Friday, November 4, 2005**. Please e-mail it to ckellen@ci.addison.tx.us.*

Please answer the following questions by placing a check mark in the box that best represents your opinion:

1. In your opinion, how beneficial is the Heart Scan in assessing your personal heart health?

☐ Not at all Beneficial ☐ Somewhat Beneficial ☐ Beneficial ☐ Very Beneficial ☐ No Opinion

2. Did the results of your Heart Scan prompt you to change your dietary habits?

☐ Yes ☐ No

3. Did the Heart Scan prompt you to seek further medical advice or testing?

☐ Yes ☐ No

4. Did the Heart Scan prompt you to increase your intensity or frequency of exercise?

☐ Yes ☐ No

5. Before undergoing the Heart Scan recently offered to you through the Addison Fire Department, had you previously had a Heart Scan performed?

☐ Yes ☐ No

6. If the Heart Scan had not been offered to you by the Addison Fire Department, would you have sought one on your own?

☐ Yes ☐ No

7. Would you like the Addison Fire Department to offer annual Heart Scans in the future?

☐

Yes

☐

No

Any

Comments:

Thank you,

Chris W. Kellen

Deputy Chief- EMS/Training

Addison Fire Department

972-450-7206

APPENDIX C

How effective have the annual cardiac stress tests been in predicting or preventing heart attacks within the Addison Fire Department?

Who was interviewed?

When and where interviews occurred? Over Phone? In person?

1. At what age was your first heart related event? _____
2. Have you ever been diagnosed with high cholesterol? Yes No
3. Have you ever been diagnosed with high blood pressure? Yes No
4. Have you ever been diagnosed with diabetes? Yes No
5. Do you currently smoke? Yes No
6. If Yes, for how long? _____
7. Do you have a family history of heart disease? Yes No
8. Are you characterized as “obese?” Yes No
9. Are you physically inactive? Yes No
10. While you were employed at Addison Fire Department, did you receive an exercise stress test?
Yes No If yes, How Many _____
11. If yes, did the stress test reveal any coronary artery disease or other abnormalities? Yes No
12. Have you suffered a significant heart-related event after a negative exercise stress test? Yes No
13. How soon after the test?
14. What type of problem and what was the treatment?
15. Did you receive a heart scan offered by the Addison Fire Department? Yes No
16. If yes, was your calcium score great than 100? Yes No
17. Did you seek further treatment because of your calcium score? Yes No
18. What treatment did you receive?

APPENDIX D

			WELLNES											
			#	PLAN/HEA	Less	5 or	Are	HS						
#	FIRE DEPT	PAID COMB VOL.	PERS	LTH	than	1-3	3-5	Stress	Stress	Heart	Effective			
			ONNE	SCREENIN	year	yrs	yrs	e	EKGs	Effect.	Scans			
			L	G										
1	Allen	YES	90	Yes	1				NO		Yes			
2	Austin	YES	998	Yes				1	Yes	Yes	NO			
3	Azle	YES	56	Yes			1		NO		NO			
4	Bryan	YES	91	Yes				1	Yes	Yes	NO			
5	Carrollton	YES	138	Yes				1	Yes	NO	NO			
6	Catw Windham	YES	93	Yes				1	Yes	YES	NO			
7	Cedar Hill	YES	56	Yes				1	Yes	Yes	NO			
8	Cleburne	YES	53	Yes				1	Yes	Yes	NO			
9	College Station	YES	115	Yes				1	Yes	Yes	NO			
10	Colleyville	YES	33	Yes				1	Yes	Yes	NO			
11	Cowtx Bill Crawford	YES	18	Yes	1				Yes	NO	NO			
12	Cypress Creek VFD	YES	100	Yes		1			NO		NO			
13	Dallas	YES	1600	NO										
14	Denton	YES	146	NO										
15	DeSoto	YES	57	NO										
16	Eastside CA Fire	YES	300	NO										
17	El Paso	YES	20	Yes				1	Yes	Yes	NO			
18	Eules	YES	61	Yes				1	Yes	NO	NO			
19	Farmers Branch	YES	65	Yes		1			Yes	unk				
20	Florida (ed)	YES	138	Yes				5	NO					
21	Flower Mound	YES	57	Yes		1			NO		NO			
22	Ft. Worth	YES	807	Yes				1	Yes	Yes	NO			
23	Garland	YES	238	Yes				1	Yes	Yes	NO			
24	Georgetown	YES	50	Yes		1			Yes	Yes	NO			
25	Grand Praire	YES	200	Yes	1				NO		NO			
26	Grapevine	YES	94	Yes		1			Yes	NO	NO			
27	Gwinnette Cour	YES	700	Yes			1		Yes	Yes	NO			
28	Highland Village	YES	60	NO										
29	Humble	YES	31	NO										
30	Hurst	YES	54	NO										
31	Hutchins	YES	13	NO										
32	Irving	YES	309	Yes			1		Yes	No	Yes			
33	Keller	YES	40	Yes			1		Yes	YES	NO			
34	Kerrville	YES	64	Yes				1	NO		NO			
35	Lubbock	YES	290	Yes		1			No					
36	Mansfield	YES	71	Yes			1		No		NO			
37	McAllen	YES		Yes		1			Yes	Yes	Yes			
38	McKinney	YES	110	Yes	1				NO		NO			
39	Midland	YES	184	Yes				1	NO		NO			
40	Missouri City	YES	55	Yes		1			NO					
41	N.Richland Hills	YES	87	Yes				1	Yes	NO	NO			
42	Noonday	Yes	23	NO										
43	Odessa	YES	162	Yes				1	Yes	YES	NO			
44	Olmos-park	YES	16	Yes			1		NO		NO			
45	Orange	YES	38	NO										

APPENDIX D

46	Pantego	YES		17	Yes		1	Yes	YES	NO	
47	Pantex	YES		60	Yes		1	Yes	NO	NO	
48	Pasadena		Yes	210	Yes	1		Yes	NO	NO	
49	Pharr		Yes	54	Yes		1	Yes	YES	NO	
50	Plano	YES		283	Yes		1	NO		NO	CRP's
51	Port Lavaca		YES	25	Yes		1	No			
52	Richardson	YES		150	Yes		1	Yes	Yes	No	
53	Richland Hills	YES		27	Yes	1		Yes	NO*	Yes	Yes**
54	Rowlett	YES		69	Yes		1	Yes		NO	
55	SAFD Brian Dui	YES		153	NO						
56	TCESD		YES	57	Yes	UNK		NO			
57	Texas Forest S	YES		52	Yes		1	NO		NO	
58	Tomball		YES	28	Yes		1	Yes	Yes	NO	
59	Trophy Club	YES		14	Yes		1	Yes	YES	NO	
60	TTFD	YES		76	Yes		1	NO			
61	Tulsa	YES		690	Yes		1	Yes	YES	NO	
62	University Park	YES		30	NO						
63	unk		YES	43	Yes		1	NO		No	
64	unk		YES	27	Yes	1		NO		Yes	Yes
65	unk		Yes	51	Yes		1	Yes	Unk		
66	Unk-Arling.area		YES	66	Yes		1	Yes	Yes	NO	
67	unk-full paid fd	YES		64	NO						
68	unk-full paid fd	YES		44	NO						
69	Unknown		YES	525	Yes		1	NO		NO	
70	Waxahachie	YES		40	Yes		1	NO			
71	West University	YES		25	Yes	1		Yes	YES	NO	
72	Westlake	YES		11	Yes		1	Yes	Yes	NO	
73	Yoakum		YES	35	NO						